

LIDAR STRATOSPHERIC OZONE MEASUREMENTS AT THE  
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Stratospheric ozone monitoring is of particular importance to confirm present day theories predicting a maximal ozone depletion, due to chlorofluorocarbon emission, in the 35-45 km altitude range. Measurements presently rely on both ground-based (Dobson spectrophotometer using the Umkehr technique) and satellite-borne passive experiments (BUV, SBUV). Such systems, however, have been recently shown to have intrinsic limitations mainly due to atmospheric aerosol presence and calibration problems (De Luisi, 1979 ; Fleig et al., 1980).

Consequently during the last few years, active lidar profiling of the ozone vertical distribution by the Differential Absorption Laser technique (DIAL) in the UV wavelength range has been developed using two different type of laser sources:

- a) Nd-Yag pumped dye lasers which enable a large tuning range of the UV emitted wavelengths from 280 nm to 320 nm (Pelon and Mégie, 1982a ; 1982b) ;
- b) exciplex laser sources using Xenon Chloride (XeCl) as an active medium and emitting at 308 nm, the off wavelength being usually generated by Raman shifting techniques (Uchino et al, 1983 ; Werner et al., 1983).

The first systems have proven their ability to study the ozone number density variations in the troposphere and stratosphere associated with short-scale and mesoscale dynamic processes. However the rapid decrease in both atmospheric total density, which provides the support for light backscattering, and ozone number density, which relates to the local optical thickness to be measured, makes measurements above 35 km very difficult without greatly increasing the laser-emitted power.

The exciplex laser sources at least ten times more powerful are thus very attractive to monitor ozone in the high stratosphere. First measurements using such a source emitting 70 mJ at 20 Hz were performed and validated during the Map/Globus Campaign in September 1983.

Figure 1 shows the average profile of the ozone distribution between 25 km (above the ozone maximum) and 48 km integrated over five nights between September 17 and September 24, 1983. The total integration time of 4 hours corresponds to  $10^5$  laser shots sequentially emitted on each wavelength. The altitude resolution is determined by the smoothing filter applied to the rough data and ranges from 0.6 km at the lower altitudes to 7.2 km at the uppermost level. Up to 30 km the statistical error stays below 2 % ; it increases rapidly above and reaches 18 % at 45 km. The results obtained by Brewer-Mast sondes and Umkehr method averaged between September 17 and September 24 are compared with the lidar measurements on the same figure.

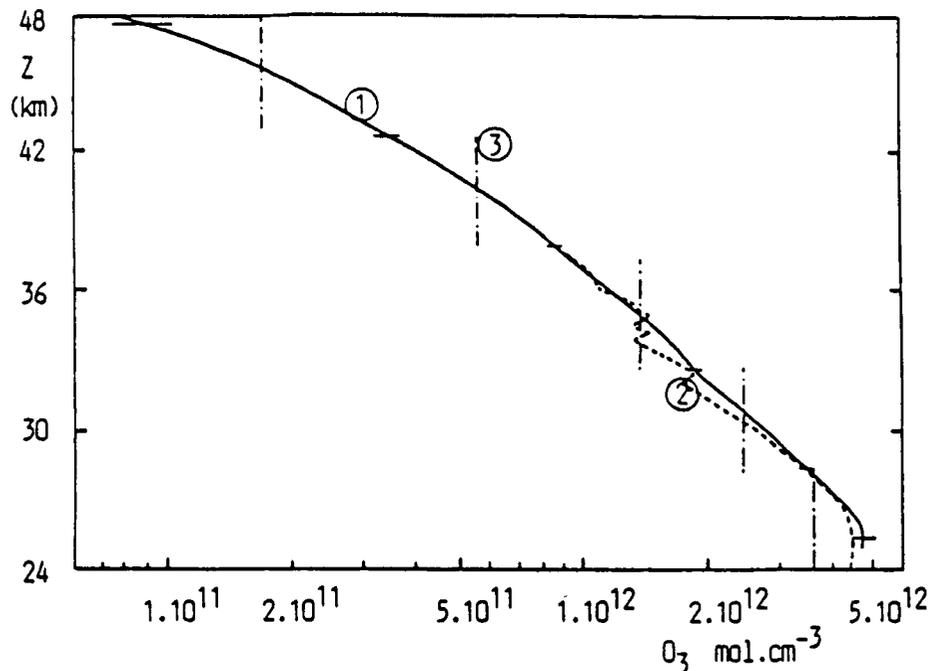


Fig. 1 Lidar averaged ozone profile (1-Full line) during five nights between September 17 and September 24, 1983, compared to the average balloons Brewer-Mast sondes profile (2-Dotted line) and to average the Umkehr profile (3-Vertical dotted line) obtained during the same period of time.

At the lower altitudes the sonde data can be considered as reliable whereas some scattering in the measurements above 30 km can already be detected due to pump efficiency problems. Considering the Umkehr data, the differences for layers 7 to 9 (32 to 48 km) are lower than 3 % e.g. within the error bars of the measurements including the uncertainties due to the calculation of the ozone concentration from Umkehr measurements and the accuracy on the ozone absorption cross sections. In layers 5 (23.5 to 28 km) and 6 (28 to 32 km), Umkehr values are lower by 20 % and 8 % respectively. This difference can most likely be attributed to the presence of aerosols at lower latitudes (De Luisi, 1979).

These measurements already give a fair evaluation of the lidar system accuracy for ozone measurements in the upper stratosphere. It can still be improved as the energy emitted by this first system is one order of magnitude lower than the one delivered by present sources. As part of the development of the OHP lidar facility an exciplex lidar system is under study to monitor stratospheric ozone concentration on a routine basis. First measurements with an oscillator delivering 100 mJ at 20 Hz were

performed in July and December 1985.

Average profiles obtained during these campaigns are compared on figure 2. They show an important difference (up to 30 %) between 28 and 40 km due to the influence of planetary waves. This dynamical perturbation must be taken into account for ozone trend determination since it represents an important part of the fluctuation spectrum and leads to uncertainties in characterizing the mean ozone trend. An evolution of the exciplex laser (emitted energy : 250 mJ at 20 Hz) will be implemented in March 1986 at the OHP for several campaigns. The whole lidar system should allow to measure ozone and temperature simultaneously.

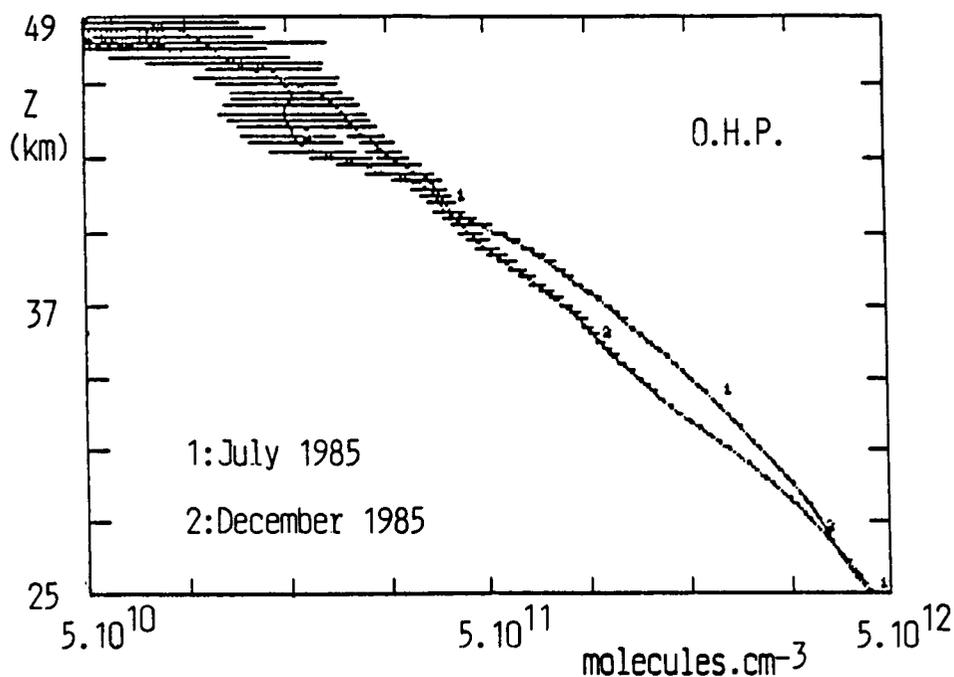


Fig. 2 Average ozone profiles measured in mid-July and mid-December 1985 at the O.H.P.

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